Issued April 27, 1908.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—Circular 147.
GIFFORD PINCHOT, Forester.

PROGRESS IN CHESTNUT POLE PRESERVATION.

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1908

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PROGRESS IN CHESTNUT POLE PRESERVATION.

INTRODUCTION.

This circular includes only points not developed in the former publications of the Forest Service[a] on similar subjects, and is based largely upon the results of a series of experiments conducted at Parkton, Md., from August, 1905, to June, 1907, in cooperation with the American Telephone and Telegraph Company.

In former experiments it was found that poles to all appearances alike showed wide divergence in their behavior during seasoning and preservative treatment. The differences were supposed to be due to the conditions of growth, but those conditions had not been exhaustively studied; hence, in the later experiments studies were made of the trees from which the poles were cut. A complete history of each pole—its life, seasoning, and treatment—was thus obtained.

The general plan of seasoning and treating was the same as that practiced in former experiments. The same apparatus was used, but the method of application was modified somewhat to obtain more specific information.

Statistics compiled by the Forest Service[b] show that 3,574,666 poles were purchased in 1906 in the United States for telegraph, telephone, electric-light, and street-railway uses. Cedar combines more desirable qualities for poles than any other wood, and 61 per cent of the poles used were cedar. Chestnut ranks next and supplied 28 per cent. The average age of a 30-foot cedar pole is about 190 years and its length of life about 15 years. We therefore consume such a pole over twelve and one-half times as fast as we can grow it. Cedar does not sprout from the stump, and its reproduction is a difficult problem. A chestnut pole of the same size can be grown under favorable conditions in about 42 years, and will last, on an average, 12 years. We consume such poles, then, only about three and one-half times as fast as we can grow them. Moreover, reproduction of chestnut is an easy problem, for it sprouts vigorously and prolifically from the stump.[c] From four to five crops of chestnut

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[a] Circular 103, "Seasoning of Telephone and Telegraph Poles;" Circular 104, "Brush and Tank Pole Treatments;" Circular 136, "Seasoning and Preservative Treatment of Arborvitæ Poles."

[b] Circular 137, "Consumption of Poles in 1906."

[c] Bulletin 53, "Chestnut in Southern Maryland."

poles can be grown to one of cedar. It seems, then, that for our future supply of poles chestnut will ultimately replace cedar, because of its ease of culture, its rapid growth, and its adaptability to use.

GROWTH AND CUTTING OF POLES.

Seed-grown chestnut trees are of slower growth than sprouts, and much fewer poles are cut from them. Of the 550 poles cut at Parkton, more than 60 per cent came from sprout trees. The average age of the sprouts was 47 years, while that of the seed trees was 57. All these sprouts came from stumps that were poorly cut and had been given no protection whatever. Had the stumps been cut with a slant and the sprouts been given a proper amount of light, it is probable that few of them would have been over 42 years of age. Some poles which met the standard requirement of 36 inches basal circumference were only 32 years old. No trees should be cut in summer or early autumn, for the stumps will not sprout, or, at best, will send forth only weak shoots. The greatest number of vigorous sprouts come from winter cuttings.

There is practically no difference in the taper between poles from sprout and those from seed-grown trees. This is shown in Table 1. No difference in specifications, therefore, need be made between the two classes.

TABLE 1.—*Comparison of poles cut from sprout and seed trees.* [a]

Class.	Tree.			Pole.			
	Age.	Height.	Circumference outside bark (4 feet 6 inches from the ground).	Circumference inside bark. At 6 feet.	Circumference inside bark. At 30 feet.	Circumference taper between 6 foot and 30-foot points.	Basis poles.
	Years.	*Feet.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Number.*
Seed	56	72	43.77	37.28	27.82	9.46	146
Sprout	51	77	45.57	37.64	28.42	9.22	118

[a] Since specifications for poles are given in circumferences and not in diameters, the former are used exclusively, in this report.

Careless cutting frequently causes decay in the stump. This decay enters the young sprouts and forms a hollow heart. Fifteen per cent of the poles cut at Parkton were decayed at the base, and 71 per cent of these were from sprout trees. The diameters of the holes varied from one-half inch to 5 inches, and the decay extended up the pole from 1 to 4 feet. Had the stumps been cut low, with a decided pitch to their surface, there would have been fewer decayed trees.

Chestnut belongs to a group of woods having a "ring porous" structure; that is, the concentric rings of large tubes which conduct water and are formed in the spring are plainly visible. The faster the growth of the tree, the greater is the amount of the denser sum-

mer wood which forms later in the year. This is the part which gives strength to the pole. A sprout-grown pole, therefore, possesses greater strength than one grown from seed. In brief, the best chestnut poles come from trees grown under a coppice management, because (1) a shorter rotation is necessary to grow them; (2) they give to the grower quicker and larger returns on the investment; and (3) they are stronger and hence safer under strain.

The height at which a pole is cut materially affects its taper. Other things being equal, a "rigid" pole—that is, one with a decided taper—is better than a "top-heavy" pole, or one with little or no taper. If cut low, the basal swelling of the tree will be included in the pole; if cut high, it will be excluded. Hence it is best for both silvical and commercial reasons to cut trees low.

It is well known that trees grown upon high elevations have a greater taper in the trunk than those grown lower down, because the soil is both shallower and drier. Poles cut from such trees, therefore, have the most taper. In the region where this study was made, the differences in elevation amounted to only 150 feet, but even this caused a marked variation. This is shown in Table 2, which is based upon 82 poles cut at exactly the same height above the ground.

TABLE 2.—*Taper in valley and hill-grown poles.*

Class.	Tree height.	Circumference inside bark.		Pole taper, circumference.
		At 6 feet.	At 30 feet.	
	Feet.	*Inches.*	*Inches.*	*Inches.*
Valley	74	37.93	28.02	9.91
Hill	66	38.07	27.23	10.84

As a result, the center of gravity in hill-grown poles is nearer the butt. For every inch increase in taper the center of gravity is about 0.15 foot lower down. In a normal pole, when the taper is about 10 inches, the center of gravity is 13.2 feet from the large end.

Specifications of the American Telephone and Telegraph Company require that a standard 30-foot chestnut pole shall be not less than 36 inches in circumference 6 feet from the butt, nor less than 22 inches in circumference at the top. A sound pole 28 inches in basal circumference is strong enough to stand the strains of a standard 30-foot pole, but as a precaution, and on account of decay, 36 inches is specified. If decay can be arrested through preservative treatment, this 8-inch allowance can be safely reduced. The top circumference would, of course, be correspondingly decreased. To find what form of pole would result from using a minimum 20-inch top circumference, as is now done in the smaller classes of poles, the tops of 350 trees, from which 30-foot poles were cut, were measured. It was found that

such poles would vary in length from 30 to 55 feet. The average increased length for those grown on hilltops was 10 feet, and for those grown on slopes and in valleys 15 feet. When the tops of trees left after the poles had been cut were utilized for cordwood, 9 to 13 cords were obtained from 100 trees, which, valued at $3 per cord, increased the gross value of the trees from 13 to 20 per cent. Utilization of the tops, moreover, improves the condition of the forest.

SEASONING.

The absolute green weight of chestnut varies with the season. This is shown in Table 3.

TABLE 3.—*Seasonal variation in weight per cubic foot.*

Season.	Poles weighed.	Green weight per cubic foot.
	Number.	*Pounds.*
Spring	150	55.6
Summer	100	56.1
Autumn	150	56.4
Winter	150	56.4

This variation in density is due to the greater amount of water and food materials stored in the tree in winter. The oven-dry weight of chestnut, obtained by sawing disks from the poles and drying them

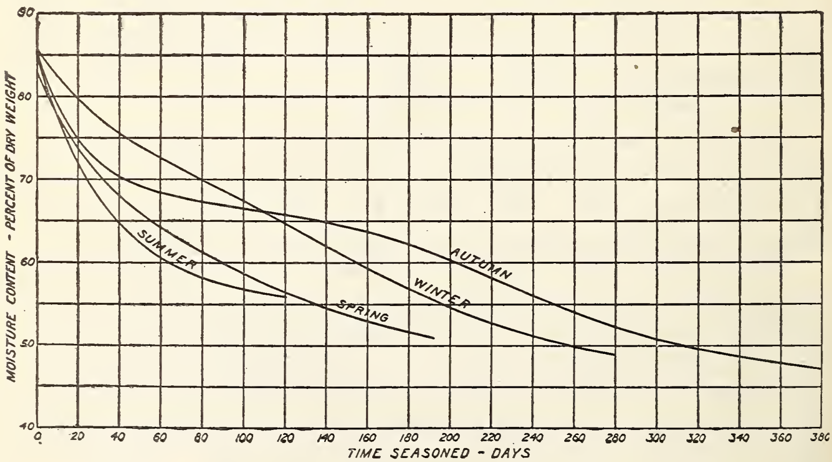

FIG. 1.—Rates of seasoning of chestnut poles cut at different times of the year.

at 100° C. until they ceased to lose moisture, was 30.4 pounds per cubic foot. This weight is used as a basis throughout this report.

The rates at which chestnut poles, cut at different seasons, lost moisture are shown in Table 4 and figure 1.

TABLE 4.—*Rate of seasoning of chestnut poles cut at different times of the year.*

Time seasoned.	Fall cut.		Winter cut.		Spring cut.		Summer cut.	
	Moisture content.	Weight per cubic foot.	Moisture content.	Weight per cubic foot.	Moisture content.	Weight per cubic foot.	Moisture content.	Weight per cubic foot.
Days.	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*
0	85.4	56.4	85.6	56.4	83.0	55.6	84.4	56.1
30	72.0	52.3	77.4	53.9	70.5	51.8	67.9	51.0
60	68.4	51.2	72.6	52.5	64.3	49.9	60.6	48.8
90	66.9	50.7	68.7	51.3	60.0	48.6	57.5	47.9
120	65.8	50.4	64.8	50.1	56.5	47.6	55.9	47.4
150	64.3	49.9	60.6	48.8	53.7	46.7		
180	62.2	49.3	56.8	47.7	51.7	46.1		
210	59.2	48.4	53.7	46.7				
240	56.0	47.4	51.2	46.0				
270	53.0	46.5	49.3	45.4				
300	50.8	45.8						
330	49.1	45.3						
360	47.8	44.9						

Table 4 broadly substantiates the results of former experiments, which indicated that the most rapid drying occurs in summer-cut poles and the most uniform drying in those cut in winter.

The reduction in weight due to seasoning is of much practical importance in decreasing the cost of shipping. Fifty green 30-foot poles loaded upon a car weigh about 56,100 pounds. The freight rate for short hauls is about 15 cents per hundredweight. It costs, therefore, $84.15 to ship such a load. If the poles are seasoned for the periods given in Table 5, the cost of shipment will be reduced about 13 per cent, a net saving of approximately $11 per car. The periods given in this table minimize the insurance and storage charges, and secure the most favorable reduction in the cost of shipping.

TABLE 5.—*Shipping table.*

Cutting season.	Ship after—	Shipping weight per cubic foot.	Moisture content compared with oven-dry weight.	Freight saved.
	Months.	*Pounds.*	*Per cent.*	*Per cent.*
Summer	2	48.8	60.6	13.0
Spring	3	48.6	60.0	12.6
Winter	5	48.8	60.6	13.5
Autumn	7	48.4	59.2	14.2

Minor points about which information was sought are discussed in the following paragraphs only in brief, but the results show how misconceived are many of the claims which have been made regarding the seasoning of poles.

Poles cut from trees grown in valleys lose about 6 per cent more moisture after six months' seasoning than those cut from trees grown on hilltops. Other things being equal, there is practically no difference between the rates of seasoning of sprout and of seed-grown poles.

Patches of bark which adhere to peeled poles decrease the rate of seasoning; they also resist the absorption of rainwater. The difference in weight at the end of one month's seasoning between those with bark and those without was 20 pounds per pole, but at the end of one year's seasoning both contained the same percentage of moisture.

The top of a pole seasons faster at first than the butt—a condition ultimately reversed. These differences cause a small shifting in the position of the center of gravity, but in no case more than an inch.

Poles exposed to the sun and wind season faster than poles skidded in protected localities. At the end of ten months' seasoning, poles skidded under the former conditions lost 26 pounds per pole more than those skidded in protected places. Skids should be built over ground which is as free of vegetation as possible. A skid built over bare ground lost, at the end of eight months' seasoning, 35 pounds more per pole than one built over a rank growth of vegetation.

Poles absorb and lose rain-water very rapidly. Absolutely green poles absorbed one-half pound per cubic foot in a rain storm of only 1.01 inches, while thoroughly seasoned poles frequently absorbed more than twice that amount.

SHRINKAGE AND CHECKING.

SHRINKAGE.

All of the poles were measured as in the previous experiments to ascertain the amount of shrinkage. The results obtained strengthen the former conclusions—that the shrinkage is so slight as to be almost negligible. In no case, even after fourteen months' seasoning, was it more than 0.3 inch. Hence the common impression that poles shrink three-fourths of an inch in circumference is entirely erroneous.

The periphery of a pole is very susceptible to meteorological influences. A rain of only 0.6 inch annulled results of four months' shrinkage, but forty-eight hours after the rainfall the poles were again in normal condition.

Another misconception is that poles expand on freezing. Green poles measured before and after being frozen showed no change in the size of their periphery.

CHECKING.

Checks in a pole decrease its strength. In general, the greater their number and the larger their size, the weaker the pole. The characteristic checks in autumn-cut and winter-cut poles are numerous and small, seldom penetrating more than 1½ inches into the pole. Checks in spring-cut and summer-cut poles are few in number, but large and deep, sometimes 1¾ inches wide, 2½ inches deep, and 10 feet long.

Besides weakening the pole, these big checks serve as pockets for the retention of rain-water. As a result, winter-cut poles are superior in strength and durability to those cut in other seasons.

Defects such as cup shakes, frost cracks, or splits from careless cutting may seriously damage the pole, especially if it be cut in spring or summer. Such defects, which are incipient in green poles, sometimes expand until they form a split a foot or more wide at the end and over 9 feet long. If such poles are treated immediately with S-irons, serious checking is prevented. Forty poles were treated in this experiment, and in none of them did the check expand more than one-half inch in width. The S-irons were made of iron one-eighth inch thick, 1 inch wide, and from 3 to 6 inches long, bent in the form of a letter S. They were driven into the ends of the pole over the check.

The practice of dragging poles for long distances over the ground should be vigorously discouraged, because thereby the outer layers of the wood are broken and sheared and the strength of the pole is materially lessened. Moreover, a pole in this condition is very susceptible to decay, because of the numerous crevices in which spores can lodge and in which rain-water can settle.

There was no apparent difference in the checking of soaked and unsoaked poles.

The size of checks varies with the atmospheric conditions, expanding and contracting with the changes in the moisture content of the air.

Poles cut in autumn and seasoned over winter recheck the following spring.

EFFECT OF SOAKING UPON SEASONING.

Fifteen poles of each month's cut were allowed to season one week and were then submerged in water for two weeks. It has been claimed that soaking dissolves out certain contents in the cells of the wood and causes it to dry more rapidly. The results in Table 6 show that this is true, but the difference in the rates of seasoning is so slight that it does not warrant the cost of the operation.

TABLE 6.—*Comparison of seasoning in soaked and unsoaked poles.*

[Moisture loss in per cent of dry weight.]

Cutting season.	Days seasoning.							
	120.		180.		275.		370.	
	Soaked.	Unsoaked.	Soaked.	Unsoaked.	Soaked.	Unsoaked.	Soaked.	Unsoaked.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Spring	27.2	27.8	31.1	31.6	....	....	....	....
Summer	25.8	27.6	....	....	....	....	....	....
Autumn	20.1	20.5	23.7	23.7	33.1	32.7	39.6	37.9
Winter	21.5	21.7	29.5	29.1	34.5	34.1	....	....

PRESERVATIVE TREATMENTS.

BRUSH TREATMENT.

In previous experiments with brush treatment the temperature and weight of the oil were taken before and after it was applied to each pole. This was too great a degree of refinement and entailed too much delay, considering the roughness of the work. In the later experiments the oil was heated in a large iron pot to about 220° F., poured into pails, and applied to the poles with brushes until it had fallen to a temperature of 200° F., when it was again reheated. Usually 5 poles could thus be treated at one time, which greatly facilitated and quickened the work. With this exception the operation followed the lines which had already been practiced.

Table 7 shows that carbolineum and creosote are absorbed in equal amounts; the first coat absorbed slightly more than the second. The depths of penetration with the two oils were also equal and averaged about one-eighth inch.

TABLE 7.—*Absorption of creosote and carbolineum by the brush method.*[a]

Absorption creosote per pole.			Average temperature.	Absorption carbolineum per pole.			Average temperature.
First coat.	Second coat.	Total.		First coat.	Second coat.	Total.	
Pounds.	*Pounds.*	*Pounds.*	° F.	*Pounds.*	*Pounds.*	*Pounds.*	° F.
2.6	2.1	4.7	214	2.7	2.2	4.9	214

[a] 92 poles were treated with each material.

Best results are obtained by applying brush treatments to only thoroughly seasoned and dry poles. Oil applied to green poles will not penetrate, and the poles will check on drying. Many of the failures in brush treatment are due to this cause. Checks in seasoned poles are wholly or partly closed by rains, and if the poles are treated with oil while they are wet, the checks reopen when the poles dry and untreated surfaces will be exposed.

There was no difference in the way soaked and unsoaked poles took treatment.

A crew of three men can treat about 50 poles per hour with the brush, if two men paint and one man turns the poles on the skids.

OPEN-TANK TREATMENT.

The apparatus used in the open-tank treatments was the same as that used in former experiments. The method of treating, however, was modified to obtain more detailed information.

There were three main questions upon which data were desired:

(1) What effect has a long duration in hot oil upon the treatment?

(2) What effect has a rapid change from hot to cold oil upon the treatment?

(3) Do poles which have been soaked in water and then seasoned take better preservative treatment?

The treatments were therefore divided into three series. The results are given in Table 8.

TABLE 8.—*Results of open-tank treatment.*

SERIES 1.—EFFECT OF DURATION IN HOT OIL.

Period of immersion.			Temperature of hot oil.	Density of outer inch.	Penetration.	Average absorption of creosote.	Basis poles.
Hot oil.	Cooling oil.	Cold oil.					
Hours.	*Hours.*	*Hours.*	*°F.*	*Rings.*	*Inches.*	*Pounds.*	*Number.*
10	14	....	228	10	0.30	20.7	16
8	14	....	223	10	.29	21.3	8
6	14	....	225	8	.34	23.6	24
4	14	....	225	8	.33	20.9	24
SERIES 2.—EFFECT OF PLUNGING POLES INTO COLD OIL.							
6	....	2	229	9	0.34	21.3	24
4	....	2	231	7	.38	20.6	16
SERIES 3.—EFFECT OF SOAKING IN WATER.							
8	14	....	225	7	0.34	17.6	8
6	14	....	229	10	.31	19.6	16
4	14	....	227	7	.35	19.1	8
4	....	2	233	9	.35	24.4	16

EFFECT OF DURATION IN HOT OIL.

Series 1 shows that there is no apparent advantage in leaving chestnut poles in hot oil longer than six hours. In those species which have a wide sapwood but the same thermal conductivity as chestnut, a longer duration in hot oil would, of course, result in a greater absorption and penetration. Because of its narrow sapwood, heating chestnut longer than six hours produces no better absorption; it volatilizes an unnecessary amount of oil, and increases the total cost of treatment.

EFFECT OF PLUNGING POLES INTO COLD OIL.

It took about twenty-one hours to secure a penetration of 0.31 inch and an absorption of 22 pounds, in the poles treated in series 1. In series 2, where the poles were heated in the hot-oil tank, and then immediately dropped into the tank filled with cold oil, practically the same results were accomplished in about one-third the time. This was due to the more rapid contraction of air in the heated wood, and a more complete utilization of the partial vacuum that had been formed. For a commercial treatment, variations of this method are recommended.

EFFECT OF SOAKING IN WATER.

Series 3, with 48 poles as a basis, shows that soaking poles in water for 2 weeks resulted in no better absorption and penetration of the oil.

EFFECT OF RATE OF GROWTH UPON TREATMENT.

In general, the more rapid the rate of growth in chestnut, the wider the sapwood and the larger the amount of oil absorbed. The relation between the rate of growth and the absorption and penetration of the oil is shown by curves in figure 2, based on the analyses of 70 poles. Chestnut cut during the period of maximum rate of

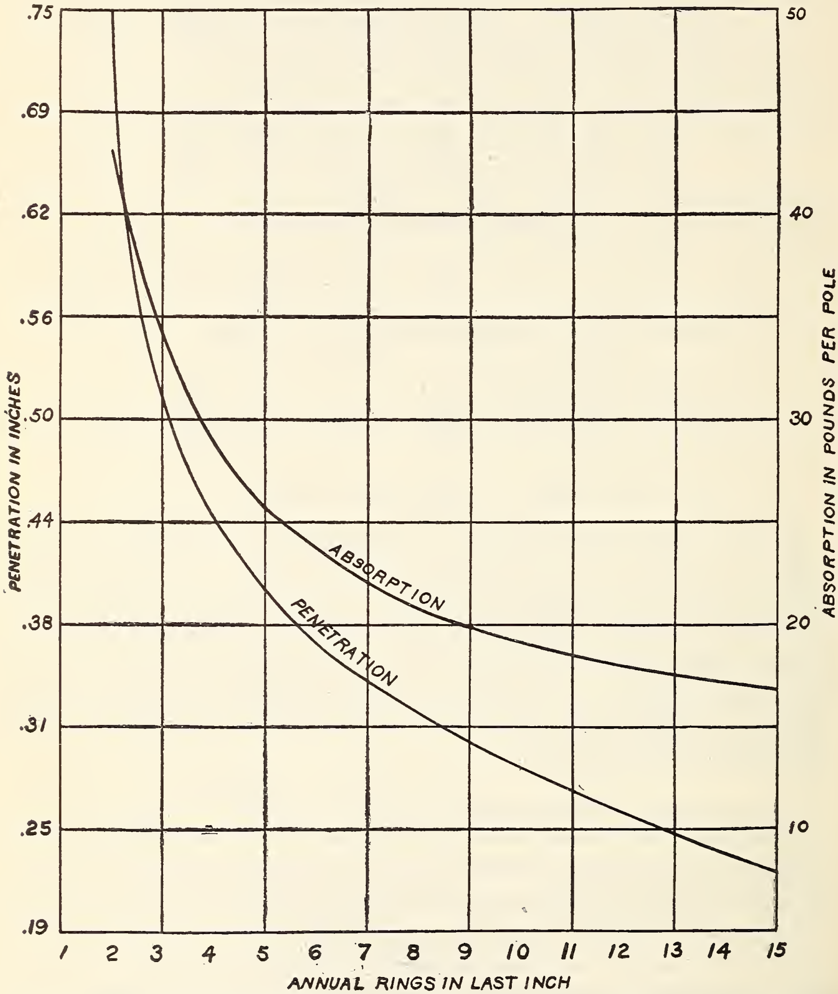

FIG. 2.—Relation of rate of growth with penetration and absorption of creosote in chestnut poles.

diameter growth is, therefore, in best condition, structurally, for treatment with creosote in the open tank, as it permits a greater absorption and deeper penetration by the oil—the two factors which, other things being equal, determine the effectiveness of treatment. The effect of rate of growth upon penetration and absorption of creosote is shown in figure 2.

EFFECT OF CUTTING SEASON UPON TREATMENT.

Effectiveness of treatment is independent of the cutting season. When differences in treatment occur, they are to be attributed more to differences in the moisture content of the poles than to differences in their physiological conditions. Thus, if chestnut poles cut at different seasons be dried to the same degree of moisture, the results of treatment will be the same. Table 9 shows the results obtained in this experiment.

TABLE 9.—*Effect of season of cutting upon treatment.*

Cutting season.	Absorption.	Penetration.	Age last inch.	Moisture content.
	Pounds.	*Inch.*	*Rings.*	*Per cent.*
Winter	23.8	0.41	9	48.4
Spring	23.2	.36	9	48.9
Summer	22.8	.34	10	49.4

EFFECT OF RAINFALL.

When experiments are conducted in the open, rainstorms destroy the uniformity of results. Thus when poles were wet they absorbed from 10 to 15 per cent less oil than when they were dry. This can be obviated somewhat by raising the temperature of the oil. Temperatures above 230° F., however, are not recommended, except as an emergency measure when the poles are wet, on account of the increased volatilization of the oil.

EFFECT OF DRAGGING POLES.

Poles that were damaged by dragging for long distances over the ground could not be given a satisfactory treatment. These poles frequently had portions of the sapwood entirely removed, and on such portions only a superficial penetration of the oil was obtained. Poles which had about one-fourth of their sapwood ground off absorbed 26 per cent less oil than those with entire sapwood. Uniformity of treatment gives best results; hence dragging should be vigorously discouraged.

TREATMENT OF POLES CUT FROM INFERIOR TREES.

Chestnut poles cut from intermediate or suppressed trees grown in valleys and in moist soil are not adapted to treatment in the open tank. A number of such poles were treated, and they absorbed only 13 pounds of oil per pole. Their penetration was only 0.19 inch. Poles of this character can be distinguished from others, as their wood is exceedingly soft and their rate of growth is very slow.

COST OF TREATMENTS.

Estimates on the cost of treatment and the economy derived therefrom have been given.[a] The variation in the method of brush treatments used later, however, brought the cost of this operation down to a commercial basis. It has been shown that chestnut poles absorbed about 4.8 pounds of oil (either creosote or carbolineum) in two brush applications. If creosote costs 12 cents and carbolineum 80 cents per gallon, the total cost of treating a pole with creosote is about 12 cents and with carbolineum 50 cents, allowing 5 cents for labor for each.

CONCLUSIONS.

The results of the experiments at Parkton corroborate, on the whole, those obtained from former investigations.

The rapid growth of chestnut, coupled with its other intrinsic qualities, renders it one of the best kinds of wood for use as poles, and the demand for it will become of much greater importance in the future.

As the best poles come from sprout trees, care should be exercised in felling. It is sound policy for all pole users to encourage a careful system of cutting.

Soaking poles in water preparatory to preservative treatment is not recommended, as it results in no better absorption or penetration of the oil.

Incipient butt or top checks caused by careless cutting or natural defects should be treated with S-irons to prevent the poles from splitting. This applies especially to poles cut in spring and summer.

Chestnut poles seasoned for the periods given in Table 5 will be dry enough for preservative treatment.

The sapwood of chestnut, which is a thin layer, should be completely saturated with the preservative. This can be accomplished by heating the poles in oil for six hours and leaving them in the cooling oil overnight, or by heating them in hot oil for four hours and plunging them into cold oil for two hours.

Effectiveness of treatment is independent of the season of cutting, but depends directly upon the moisture content and the width of the sapwood. Chestnut poles cut during the period of maximum rate of diameter growth and thoroughly seasoned admit of best results in preservative treatment. Spring and summer cut poles reach such a condition more quickly than those cut in autumn and winter.

Approved:

JAMES WILSON,

Secretary.

WASHINGTON, D. C., *March 9, 1908.*

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[a] Circular 104, "Brush and Tank Pole Treatments;" Circular 136, "Seasoning and Preservative Treatment of Arborvitæ Poles."

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